How pre-danger fear changes when entering adulthood

Name: Jenny Pham

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Introduction

Have you ever wondered why some of you 'grew out' of that rush of panic before you descended a rollercoaster or a steep hill on your bike. Or perhaps you never 'grew out' and developed a fear of such situations? Why was there a rush of panic before you even experienced the danger? Why does the experience vary between people? What does this dynamic pre-danger response indicate about our biology and how can it be useful?

The aim of this investigation was to provide an explanation to why short-term stress, which is experienced before descending a slope, changes when growing from childhood to adulthood. Some of the theories and explanations explored in this investigation can be generalised to explain other fears.

Background Information

The change in how fear is experienced can be explained by anyone, two or three of the following theories:

1. Theory of Habituation

   The theory of habituation is a non-associative learning method in behavioral psychology that describes how repetitive or prolonged exposure to stimuli reduces the natural response to it (Benito-Walther, 2015). The habituation model is used as an exposure-based therapy to reduce responses to phobias and decrease anxiety level when exposed to the stimuli. However, the habituation model can be indeliberately applied from frequent exposure to stimuli when moving from childhood into adulthood. This theory can explain why children tend to 'grow out' of their fears; and no longer experience or experience less arousal when exposed to the fear as adults.

   The exposure component in this investigation is measured by the participant's self-reported response to the question "Growing up, do you often cycle where you have to

descend slopes like these?". The innate natural response is measured by the heart rate change from the resting heartrate in BPM to the heartrate prior to descending the slope. The alternate hypothesis for this theory is that the participant's self-reported higher exposure to descending slopes will decrease their heartrate change as measured when the participant is resting then when the participant is on a bike about to descend the slope. The null hypothesis for this theory is that the participant's self-reported exposure to descending slopes will not affect their heartrate change as measured when the participant is resting then when the participant is on a bike about to descend the slope.

2. Desensitized Adrenergic Receptors Theory

   The sympathetic adrenal system (SNS) is responsible for the body's 'fight and flight' response to short-term stress from danger or fear. In the context of this study, when the participant is exposed to the potential of facing danger by descending a slope, they will experience the SNS response. Because the system affects many organs throughout the body, this experiment measures the response by the cardiac response. The brain recognizes the stressor and the chromaffin cells in the adrenal medulla as well as postganglionic fibers produce catecholamine. This hormone activates the cardiac adrenergic receptors which accelerates heartrate. When aging, the sympathetic nervous system becomes more active; however, the sensitivity of the system is decreased because the cardiac adrenergic receptors reduce in sensitivity and quantity. This effect can be used to predict the reduced sympathetic nervous response in adulthood relative to children because of adult's less sensitive adrenergic receptors. The sensitivity of the cardiac response will be measured by the change heartrate of the participant in BPM at rest versus prior to descending the slope. The manipulated variable is the age of participants

which will be done by selecting a group of children and a group of adults. The alternate hypothesis for this theory is that the adults will have a lower change in heart rate than the children. The null hypothesis predicts that age will have no effect on the change in heartrate.

3. Geographical Slant Perceptual Bias Theory

The overestimation of the steepness of hills and vertical lengths and heights is a common perceptual bias. The attempts to explain this perceptual bias includes that depth perception juggles spatial considerations, or that vertical lengths and depths have a visual tunneling effect, or that the inclines are juxtaposed and compared to flat horizontal surfaces, or because human visual systems are evolved to be overly sensitive to slight inclines from the horizontal to keep the body upright (University of Virginia, 1999). No matter the source of the distortion, it can be used to partially justify some fears such as acrophobia (fear of heights) and bathophobia (fear of depths) because the downwards vertical length is perceived as significantly longer than reality. However, because the vertical plane is a component of an inclined plane, this perceptual bias can be described to an extent to be a contributing factor of causing anxiety and short-term stress the same way the bias causes stress for acrophobia and bathophobia. This can be tested from verbal anecdotal estimations of the steepness of a slope which will be plotted against the change in heartrate from rest to before descending the hill. The predicted effect is that participants who estimate a steeper incline will have a greater increase in heart rate.

To extend the theory to the aim of this study, the participants will estimate the steepness of the hill at 2 different eye levels – a ‘child’ eye level and an ‘adult’ eye level. This is to replicate the perspective of the slopes at the respective stages of life. If there is a

difference in the perspectives, this indicates that the change in the stress from childhood to adulthood may be a result of differing perception of the slope.

The alternate hypothesis predicts that there will be a discrepancy between the ‘child’ eye level and the ‘adult’ eye level because the elevation of the eyes from the slope will affect the field of view and perceived steepness of the slope as shown in the 2 annotated photos below. Although both photos are taken at 0° angle of depression, the road appears more distorted and occupies more of the field of view in the ‘child’ view. The red line marks the halfway mark between the top and the bottom of the slope. In the ‘child’ view, the line appears closer to the bottom of the slope.

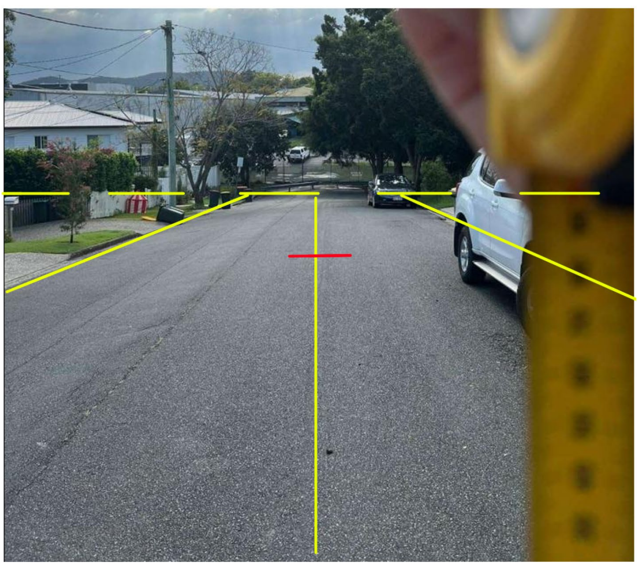

Figure 1: Field of view for ‘adult’ eye level (160cm), created by author

Figure 2: Field of view for ‘child’ eye level (70cm), created by author

Variables & Hypotheses

Each of the following theories were explored in a combined experimental procedure with the same subjects, but separate experiments. Table 1 is an overview of the variables and hypotheses for each of the theories addressed.

Table 1: Variables and hypotheses for 3 main theories.

Theory of Habituation Experiment		
Variables		
Variable Type	Variable	Operationalization
Independent (Quasi)	Adults who had exposure to stimulus growing up vs. adults who did not have exposure to stimulus growing up	Self-reported response to question
Dependent	Heart rate change from rest to prior to descending hill	Measured on a smart watch when calm then measured again when about to descend slope
Hypotheses		
Alternate Hypothesis	The participant's self-reported higher exposure to descending slopes will decrease their heartrate change as measured when the participant is resting then when the participant is on a bike about to descend the slope.	
Null Hypothesis	The participant's self-reported exposure to descending slopes will not affect their heartrate change as measured when the participant is resting then when the participant is on a bike about to descend the slope.	
Desensitized Adrenergic Receptors Experiment		
Variables		
Variable Type	Variable	Operationalization
Independent (Quasi)	Adults vs. children	20-22 years old participants vs. 7-9 years old participants
Dependent	Heart rate change from rest to prior to descending hill	Measured on a smart watch when calm then measured again when about to descend slope
Hypotheses		
Alternate Hypothesis	The adults will have a lower change in heart rate than the children.	
Null Hypothesis	Age will have no effect on the change in heartrate.	
Geographical Slant Perceptual Bias Experiment		
Variables		
Variable Type	Variable	Operationalization
Independent	'Adult' eye level vs. 'Child' eye level	Adjusting participant's eye levels to 160cm vs. 70cm on a measuring tape
Dependent	Verbal estimate of steepness of hill	Response to instruction using a graphic. Response between 0-90°.
Hypotheses		
Alternate Hypothesis	There will be a discrepancy between the verbal estimates of the steepness of the hill in 'child' eye level versus the 'adult' eye level.	
Null Hypothesis	There will be little discrepancy between the verbal estimates of the steepness of the hill in 'child' eye level versus the 'adult' eye level.	

Exploration

Research Design: Quasi and Laboratory Experiment Hybrid

Sample

The sample was consisted of 20 adults and 10 children which were opportunity sampled through SMS messaging, and 'snowball sampled' friends of those directly contacted.

Participants

The mean age of adults was 21.05 years old, and the mean age of the children were 7.9 years old. There were 22 females and 8 males in the study. All participants were Vietnamese. All adults had high English proficiency and 19 were completing an undergraduate or higher degree in Brisbane when the experiment was carried out. None of the participants had a history of cardiovascular health problems and none were on adrenergic receptor blocking medication or centrally acting drugs. Eyeglasses were allowed; however, participants were not allowed any other tools to aid in their verbal estimate. All participants over 18 have signed an informed consent form prior to the commencement of the experiment which informs them of the content of the experiment, the aim of the investigation, and how their data will be used. Participants who were under the age of 18 had their legal parent or guardian sign the consent form in the place of the child

Controls

The heartrate was taken by the difference between the initial heart rate at rest and the heart rate when the participant is exposed to the stressful stimulus. This was done to account for participant variability since different participants have different resting heartrates and comparing only the final heartrate does not mean anything. If only the final heartrate was taken, this would not be

representative of the cardiovascular response because it does not account for the participant's initial heartrate.

Because the experimental design for the Geographical slant perceptual bias experiment was repeated measures. Due to order effects, this makes participants prone to demand characteristics for the second condition because the participant would notice the independent variable and would thus change their answer on the basis that the experiment expects the estimates for the steepness are different. Rather, this experiment requires the participant to make a genuine estimation based on the discrepancy in the two fields of view, rather than an estimation based on game theory. This was controlled by counterbalancing the conditions. 10 of the participants did the 'child' eye level before the 'adult' and the remaining 10 participants did the vice versa. By doing so, the order effects and carryover effects are balanced. This control consequently increases the internal validity of the result and thus conclusions of the experiment.

Another control was to restrict participants who had a history of cardiovascular health problems or are on adrenergic receptor blocking medication or centrally acting drugs from taking part in the experiment. This is because these drugs biologically modify the participant's cardiac system which will affect the dependent variable in the theory of habituation experiment and desensitized adrenergic receptors experiment. Therefore, the participant's result would have not been representative of a healthy regular person's sympathetic nervous response to the pre-danger fear prior to descending a hill.

To restrict the extraneous variables that may contribute significantly to the increase in a person's heartrate, the experiments were performed between 8am and 4pm when it is light out.

Additionally, the experiments were not performed if it had rained previously or was raining. By doing so, the fear of getting soaked or slipping or fear of the dark would contribute to the rise in heartrate.

Another control to increase the trial reliability and replicability is by marking a fixed spot for where all participants stand and take measurements from and are stopped at when riding the bike. This is so that all participants will have the same controlled field of view and 'feeling' of the inclination of the slope and thus the trials will be replicable and fair.

Materials

- 1x Stanley steel measuring tape 8m
- 1x Gloryfit smartwatch with heartrate monitor 1hz
- 1x smartphone with 12-megapixel camera
- 1x Tempest aluminum bike

Procedure

1. The participant was given and signed an informed consent form prior to the commencement. Child participants' parents were given the informed consent form in the place of the child.
2. The actual angle of elevation of the slope was taken by an inclinometer app on a smartphone at 3 points of the slope – the top, the bottom, and the approximate midway point. The inclination of the slope on all 3 points was determined to be 6°.
3. The participant was taken to the top of the slope and instructed to stand at the fixed marked point.
4. Participant was asked the questions to which they may respond 'yes'/'no':
    a) Do you have a history of cardiac problems or conditions?
    b) Are you on any stress medication such as beta blockers?
    c) Growing up, did you often cycle where you had to descend slopes like these?

    If the participant responds 'yes' to either question (a) or (b), the trial was discontinued. The responses for question (c) were recorded.

5. The participant was asked if they were completely relaxed after climbing the hill
6. A smart watch was worn by the participant and their initial/resting heartrate was recorded.
7. The participant was instructed to adjust their eye level to 70cm on the measuring tape from the ground by sitting or squatting or kneeling. For other half of the participants, they were instructed to adjust to 160cm to counterbalance.
8. The participant was shown the image in Figure 3 (right) and their response to the instruction on the image was recorded.
9. The participant was instructed to adjust their eye level to 160cm on the measuring tape from the ground by squatting or standing. For other half of the participants, they were instructed to adjust to 70cm to counterbalance.
10. Step 8 was repeated once
11. The participant was led past the top of the slope where there was an even area of 2° incline. They were instructed to mount the bike with a helmet and descend the slope.

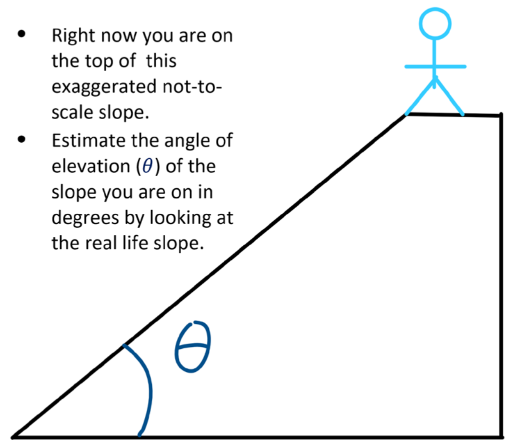

Figure 3: Instructions for Participant by author

12. The naïve participant was stopped when they reached the marked point where the 2surface met the 6 Their final heartrate was taken from the smartwatch.
13. For the child participants, only steps 5, 6, 11, 12 in the respective order were completed. Child participants used their own bike instead of the provided bike.
14. The steps 1-13 were repeated for all participants. The experiment was concluded.

Risk Assessment

Table 2: Risk assessment and management

Risk	Chance of Occurrence	Severity	Management
The participant may fall off the bike causing injury to themselves and damage to materials	High	Medium	First aid was brought to the site of the experiment. Participants will only be descending a 2° slope at a speed slower than walking speed and stopped before the slope become steeper. The experiment will not be held when dark, raining or after rained. All participants wore a helmet adjusted to fit. Participants are allowed to drop out of the experiment at any time if uncomfortable.

Cars may hit the participant on the road.	Low	High	The experiment was held on a no-through road in a residential outside of peak hours (8am and 4pm) when there is rarely car traffic. The researcher hosting the experiment wore a high-visibility fluorescent sleeveless jacket.

Analysis

Descriptive Statistics

Table 3 : Table showing the Mean and Standard Deviation of the results of each condition

Condition	Mean	Standard Deviation
Estimated angle at 70cm eye level	33.7	8.4
Estimated angle at 160cm eye level	37.1	11.0
All adults change in heart rate	7.7	3.6
No exposure adults change in heart rate	9.9	2.4
Exposure adults change in heart rate	4.4	2.1
Children change in heart rate	10.1	2.1

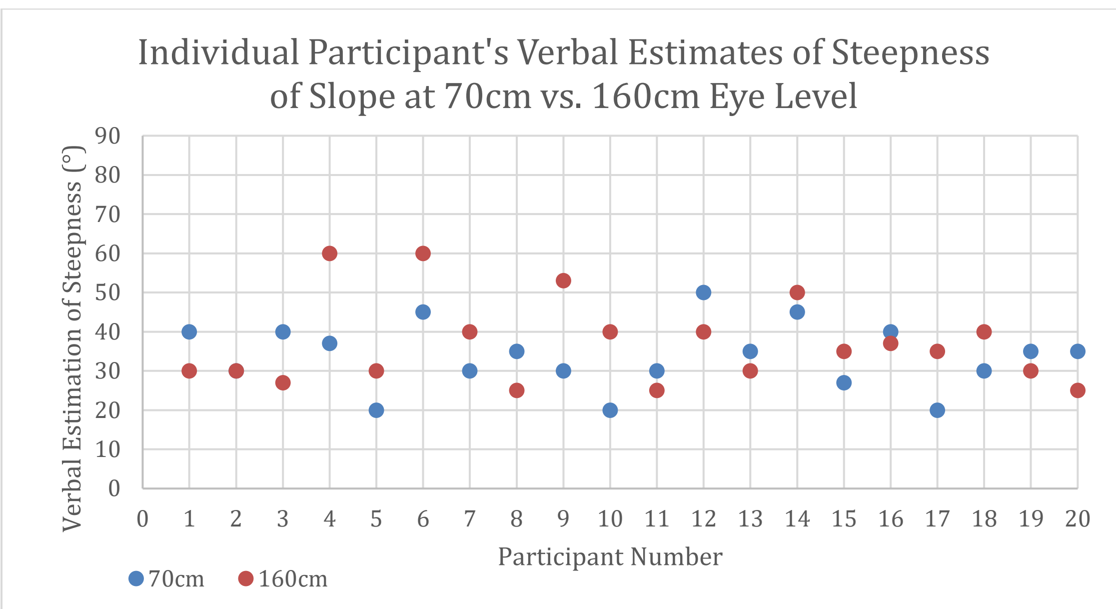

Figure 4: Individual Participant's Verbal Estimates of Steepness of Slope at 70cm vs. 160cm Eye Level by author

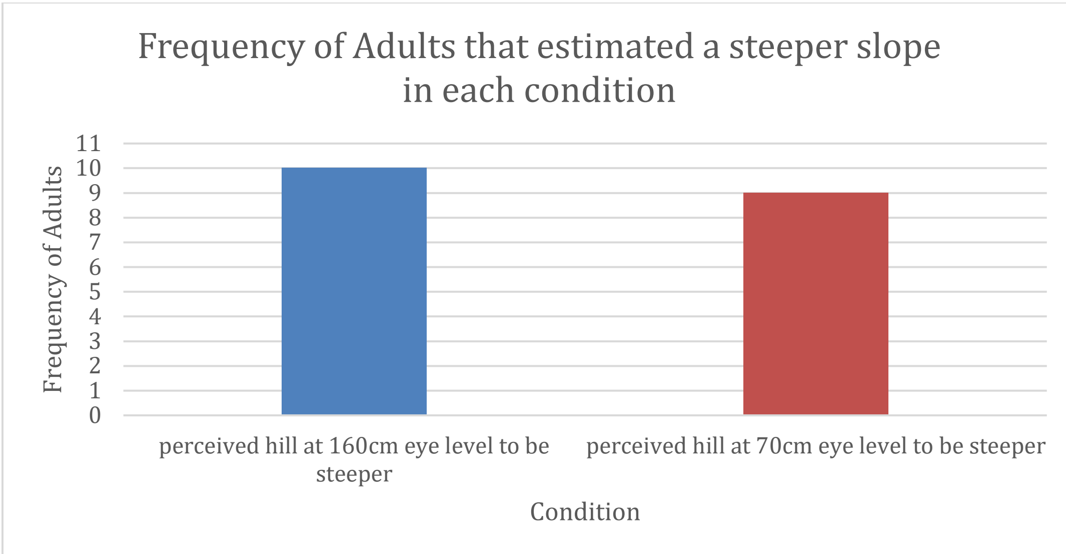

Figure 5: Frequency of Adults that estimated a steeper slope in each condition by author

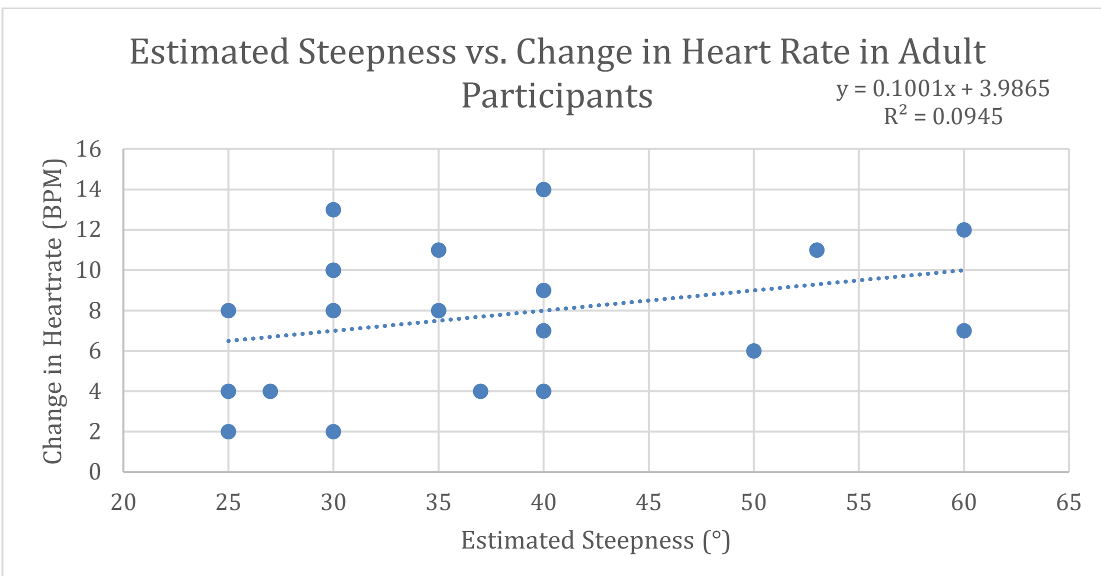

Figure 6: Estimated Steepness vs. Change in Heart Rate in Adult Participants by author

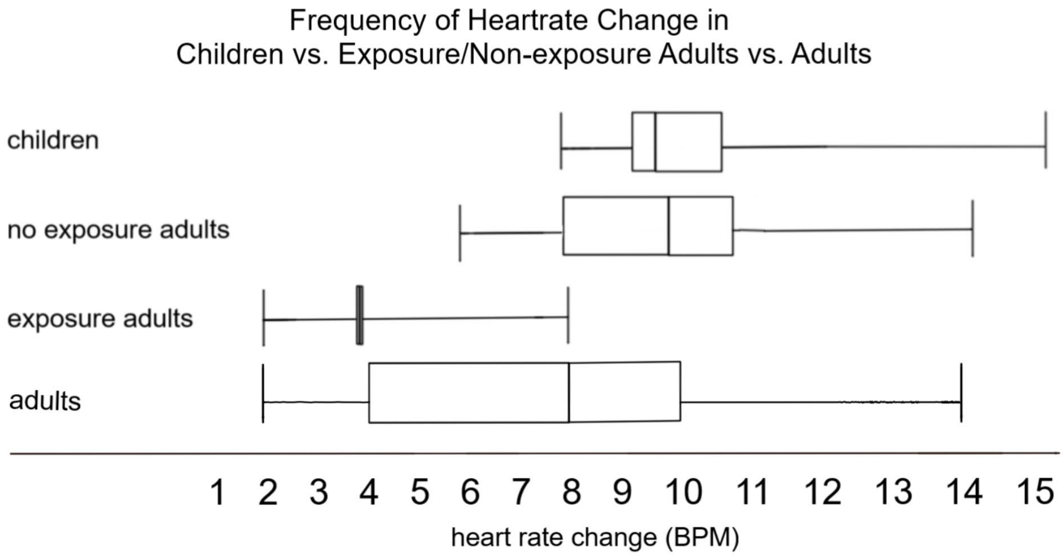

Figure 7: Frequency of Heartrate Change in Children vs. Exposure/Non-exposure adults vs. all adults by author

Discussion

Figure 4 indicates that, not only do all adults overestimate the steepness of the slope, but there is also a discrepancy between the estimates in the 'adult' versus the 'child' eye levels. This proves the alternate hypothesis for the perceptual bias theory that the eye level will have an effect on the perceived steepness of the slope. However, the 'effect' cannot be predicted because, as seen in Figure 5, half of the participants estimated the hill was steeper at the 'adult' eye level whereas the other half estimated the hill to be steeper at the 'child' eye level. The extension of this theory was to investigate the correlational relationship between estimated steepness and cardiovascular response to stress. Figure 6 has demonstrated that the correlation co-efficient for the correlation is extremely low because of the random error in the result. The trendline indicates a positive trend however this is irrelevant because the coefficient of determination of 0.0945 shows that the residuals are too large and 90.55% of data points are random. Thus, a correlation cannot be inferred.

Figure 7 shows the frequency of each heart rate change score on a box plot. This diagram shows the results relative to the other quasi groups as well as the standard deviation. It can be deducted that there is a difference between the cardiovascular responses between children and adults, however the spread of the result for adults overlaps with that of the children largely. Additionally, Table 3 shows that the standard deviation for the adult group is also 3.6 which is significantly higher than the other groups. Therefore the result is too unreliable to draw a conclusion that there is a significant biological difference in cardiovascular responses between children and adults. However, a conclusion that can be withdrawn from Figure 7 is that there is a difference between adults who had exposure to riding down bikes when growing up versus adults that didn't. Exposure adults had significantly less heart rate change than non-exposure adults and children (who presumably also had less exposure). This aligns with the hypothesis that frequent exposure leads to habituation which reduces the response to frequented stimuli. The narrow second and third quartiles for exposure adults and moderately narrow quartiles for the nonexposed adults (relative to the standard deviation for all adults group), the conclusion that the hypothesis for the theory of habituation has been verified is justified.

Assessment of Methodology

Table 4: Source of error and improvements

Source of Error & Impact on Data	Improvement
Using a wrist-worn heartrate monitor to measure the SNS response to short-term stress is inaccurate because it measures the heartrate through the wrist and not directly from beating of heart, which may have caused a delay.	Use of an arm band heart rate monitor will be more localized. A more invasive but accurate improvement will be using an implantable loop recorder.
Taking only 2 measurements of heartrate is not representative of cardiovascular response because it only represents a small window. Additionally, using only 2 data points amplifies any error	Instead of measuring heart rate, measure heartrate variability, which are fluctuations in the heartbeat intervals, can provide more precise data and more data points.

Conclusion

This investigation aimed to provide an explanation to why short-term stress, which is experienced before descending a slope, changes when growing from childhood to adulthood. The investigation found that the overestimation of the steepness of geographical slants does not correlate to the pre-danger fear, however there is a discrepancy between the point of view of a child's versus an adult's. There was an overlap in the results between adults and children in their heart rate change when experiencing this pre-danger fear. This indicates that there is little difference in the cardiac biology between adults and children in an SNS response, thus demonstrating that the desensitization of cardiac adrenergic receptors is insignificant between the two age groups. The investigation also discovered that exposure to this stimulus is a significant contributing factor to the intensity of the cardiovascular response as part of the SNS response. Adults who had exposure to riding down slopes on bikes generally had 55% less increase in heartrate from rest than adults and children who did not have the exposure. The conclusion that can be drawn from the findings of this investigation is that the difference in short-term stress experienced prior to descending a slope can be explained by the theory of habituation and partially by the cardiac biological differences between children and adults (but cannot be explained using specifically the theory of the desensitization of cardiac adrenergic receptors).

Real life Application

An application of the findings of this research is that it can contribute to the wider scientific context of research in behavioral and learning psychology in children because of the discovery that habituation can be applied as a learning theory to mitigate intense stress response in adulthood. This investigation has discovered that stress can be integrated into learning for a positive outcome. This knowledge can be built upon integrated into education systems to support

learning for children. A potential expansion of this study is by researching how exposing children to controlled doses of a stressful stimulus can reduce the stress response to other stressful stimuli.

Another scientific umbrella that this investigation has contributed to is therapeutic methods. Exposure therapy is a controversial method used to treat anxiety disorders and phobias because of the strain it has on the individual using the therapy. This investigation shows the short-term cardiac response to the exposure-therapy-like treatment and also shows the long-term positive effects of natural exposure to stressful stimuli on the person's stress response. Typically, research on exposure therapy investigates forceful and controlled exposure to stressful stimuli instead of natural stimuli. This investigation provides insight into how natural stimuli may be just as effective as the industry standard at reducing anxious responses.

Another wider scientific context that this investigation contributes to is the research for perceptual biases and geographical visual illusions and their effect on stress and fear. Although this investigation indicates no positive correlation between the two variables because fear was measured only by the cardiac response. The cardiac response is only part of the 'fight and flight' response which is an extreme reaction to fear, thus is not representative of the variable. Thus, further research can be performed on the relationship between how the world is seen, and how fear is developed from what is seen.

References

Lohse, M. J., Engelhardt, S., Danner, S., Bohm, M. (2020). 'Mechanisms of beta-adrenergic receptor desensitization: from molecular biology to heart failure'. Pucmed. https://pubmed.ncbi.nlm.nih.gov/8957541/ [accessed 12/09/2022]

Schallhorn, C. (2012). ‘Sensory Adaptation v Habituation’. Youtube. https://www.youtube.com/watch?v=PnKSA6fGp6w [accessed 12/09/2022]

Battlaglia, S., Orsolini, S., Borgomaneri, S., Barbieri, R., Stefano, D., Pellegrino, G. D. (2022). ‘Characterizing cardiac autonomic dynamics of fear learning in humans’. Wiley Online Library. https://onlinelibrary.wiley.com/doi/10.1111/psyp.14122 [accessed 20/09/2022]

Shaffer, D. M., Flint, M. (2010). ‘Escalating Slant: Increasing Physiological Potential Does Not Reduce Slant Overestimates’. Sage Journals. *22*(2). https://journals.sagepub.com/doi/abs/10.1177/0956797610393744 [accessed 12/09/2022]

Scientific American (2011). ‘People Overestimate Steepness’. ScientificAmerican.com. https://www.scientificamerican.com/podcast/episode/people-overestimate-steepness-11-02-16/ [accessed 20/09/2022]

Seals, D. R., Esler, D. M. (2000). ‘Human Ageing and Sympathoadrenal system’. Pucmed. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2270159/ [accessed 20/09/2022]